THE DENTAL PRACTITIONER

AND DENTAL RECORD

Including the official reports of the British Society of Periodontology, the British Society for the Study of Orthodontics, the European Orthodontic Society, the Glasgow Odontological Society, the Liverpool and District Odontological Society, the North Staffordshire Society of Dental Surgeons, the Odonto-chirurgical Society of Scotland, and the Dental and Medical Society for the Study of Hypnosis

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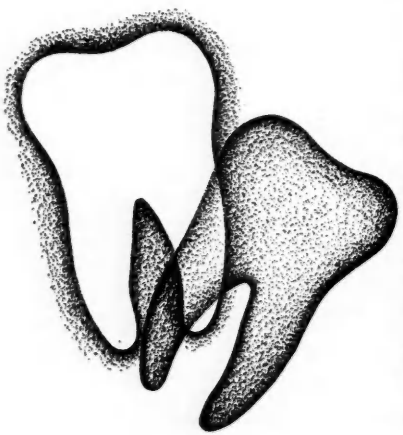

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THE DENTAL PRACTITIONER AND DENTAL RECORD

Vol. VIII, No. 11 July, 1958

EDITORIAL

NASMYTH'S MEMBRANE

THE name of Alexander Nasmyth will be remembered by readers from their early student days, when they attended lectures on dental anatomy. The membrane that covers the surface of the enamel still bears his name and is an everlasting memorial to his work. However, it must be admitted that most people, after years of practice, remember little more about this particular membrane beyond the simple fact of its name. Our memories of this structure will be revived on reading the article by Turner in this issue. Since the war the accent of dentistry has been on the prevention of dental caries, and if this prevalent disease commences, as most people acknowledge, on the outer part of the enamel, then the covering membrane must automatically require investigation. It is undoubtedly an important facet of prevention, and although Nasmyth first described the membrane in 1839, there is still a great deal of investigation to be undertaken before we know its exact relationship to the carious process.

It has been the policy of this JOURNAL to print a certain number of research articles every year and we feel that this particular article will appeal to those practitioners who are interested in prevention. The article is appropriate in that the Memorandum on Dental Research in the United Kingdom (prepared by the British Dental Association) has just been published. This Memorandum shows that while there is difficulty in staffing and space, there is a nucleus of research workers who are obviously filled with enthusiasm. They must be given full encouragement if the place of British Dentistry is to maintain its high standing in the world. It is to be hoped that many of the recommendations in the Memorandum will be developed and put into practice.

CHAIR OF DENTAL SURGERY AT EDINBURGH

It has been announced that Professor John Boyes has been appointed to the Chair of Oral Surgery in the University of Edinburgh and will succeed Professor A. C. W. Hutchison, who is retiring. Professor Boyes is the present holder of the Nuffield Chair of Oral Medicine in the University of Durham.

HONORARY FELLOWS OF THE FACULTY OF DENTAL SURGERY, ROYAL COLLEGE OF SURGEONS OF ENGLAND

It has been announced that Honorary Fellowships of the Royal College of Surgeons are to be conferred on Sir Henry Souttar, Mr. Ralph Huffan, and Dr. J. Menzies-Campbell. Dr. Menzies-Campbell is a well-beloved figure in the dental profession, whose pen has adorned these pages with many of his historical notes.

LININGS AND THEIR MANIPULATION

By **J. J. MESSING**, B.D.S. (Dunelm.), F.D.S. R.C.S. (Eng.)

University College Hospital Medical School, Dental Department

THE purpose of a lining is to insulate the pulp from thermal shock, and in those cases where there are dissimilar metals in opposing teeth, it is possible that protection is afforded against electrical shock. In addition it presents a barrier to acids and other irritating constituents in acrylic and silicate restorations.

It is now generally accepted that the need for a lining progressively increases as the cavity becomes deeper. Manley (1936) and Kramer and McLean (1952) have shown that silicate and acrylic restorations cause varying degrees of pulpal damage, and consequently must be separated from the pulpal wall of the cavity by a lining.

It is the purpose of this paper to describe the various types of lining material and indicate those methods of manipulation which the writer has found to be advantageous in practice.

When we examine the materials at our disposal, it is obvious that zinc phosphate cement is most widely used. This material has a crushing strength well within the limit imposed by normal packing pressures during the condensation of amalgam; it sets quickly and does not stain the dentine but adheres firmly and, when mixed correctly, causes little reaction in the pulp.

Nevertheless, in spite of this, the *p*H of even correctly mixed cement, when newly inserted, is in the region of 1·6, and this has been incriminated as the cause of pain in deep cavities although it attains neutrality in 24 hours (Skinner, 1954). The practitioner is unable to appreciate whether the pain, produced after insertion of a filling, is due to cement irritation alone or to a combination with trauma produced during cavity preparation. This irritation can be prevented by the use of zinc oxide–eugenol cement under the zinc phosphate lining, or by attenuating the acidic reaction of the cement by mixing equal parts of eugenol and phosphoric acid immediately prior to spatulating. Mosteller (1951) showed that the value of this addition is apparently due to the sedative action of the eugenol rather than to any reduction in acidity, and although the crushing strength is reduced by 30 per cent, it is still adequate. The setting time is also reduced, but this is not so marked as to interfere with manipulation.

Zinc oxide–eugenol cement has long been used by the dental profession as a means of allaying pulpal pain, and because of its sedative properties it is used under phosphate cement in deep cavities. However, as it sets slowly, it does not attain a sufficient degree of hardness for several hours, so at a subsequent visit it must be trimmed and covered with a layer of phosphate cement. Alternatively an accelerator can be added which decreases the setting time to a few minutes. The commonest materials employed as accelerators in zinc oxide cements are zinc acetate, zinc stearate, and acetic acid. Rosin has been used in some brands as a hardener, but this tends to make the cement very sticky and difficult to manipulate.

The crushing strengths of various proprietary brands of zinc oxide–eugenol cement were worked out by Warren Harvey (1946) and found to be between 810 and 3430 lb. per sq. in. Marie Gayler (1933) has shown that hand-packing pressures during the condensation of amalgam vary from 300 to 6000 lb. per sq. in., so it is doubtful whether zinc oxide–eugenol cements will stand up to the pressure of packing amalgam unless they are inserted as a thin layer and covered by a relatively thicker layer of phosphate cement.

Practically, one may be justified in placing an amalgam restoration directly over a quick-setting zinc oxide lining in a small four-walled cavity, but any attempt to pack amalgam into a Class II cavity, lined solely with zinc oxide cement, may result in failure because the cement will tend to crumble and be extruded at the gingival margin, thereby resulting in a deficient filling.

If the pulp has been accidentally exposed and the cavity is completely free from caries

and uncontaminated by saliva, the use of a pulp cap or pulp dressing is often indicated. Two other factors increase the chance of success. Firstly, the tooth should have been previously symptomless and its pulp reaction normal, and secondly the pulp should not have been traumatized, as for example whilst testing for the exposure with a probe. Whether or not a pulp cap is used is a matter of personal preference, but it is imperative that whatever drug or paste be applied to the exposure, no pressure should be used, in order that the pulp be undisturbed and given every chance to recover.

There are three substances, all of which have been tried by the writer with considerable success in selected cases, namely, zinc oxide–eugenol quick setting cement, calcium hydroxide, and Thymozin; the latter is used either as a dry powder or as a suspension in methyl cellulose. In the next section the manipulation of these materials will be described.

Zinc Oxide–Eugenol Cement.—This cement has two uses as a lining: to protect the pulp from potential irritation by phosphate cement, and as a dressing on an exposed pulp.

When a simple zinc oxide–eugenol cement is mixed, as much powder should be brought into the liquid as can be absorbed, to make a thick mix which is not sticky. This is lightly squeezed between the folds of a napkin immediately before use and pressed home into the cavity with a flat plastic instrument. The surface is contoured with a smooth cement plugger using light sharp taps. The instrument is dipped into zinc oxide powder whenever necessary to prevent the cement adhering to it. It is preferable to use a quick-setting zinc oxide cement layer beneath the phosphate cement when an immediate filling is to be inserted into a deep cavity. This base should be mixed as thickly as possible but not squeezed out. A small pellet is picked up on a probe, and without touching the cavity margins is inserted into the deepest part of the cavity. A small tight pledget of cotton-wool is then moistened with water, all excess being expressed so that it is just damp, and used to even out the dressing over the pupal wall. The moisture accelerates setting.

When covering an exposed pulp, the chief difference from the above method of applying a dressing lies in attempting to avoid all pressure. First, a quick-setting zinc oxide cement is desirable. This is mixed to a sticky consistency, picked up on the point of a probe, and placed on the dentine near to the exposure. While still soft, it is teased across from wall to wall, and using small excavators dipped in zinc oxide powder, is pressed against the lateral walls, without any attempt being made to pack down on to the pulpal wall. After about five minutes have elapsed, a layer of phosphate cement can be gently placed without fear of exerting pressure on the dressing over the pulp. Needless to say, any symptoms indicative of pulpitis, or any gross change in vital response, must be treated by more radical pulp therapy.

Calcium hydroxide can be insufflated on to the dentine surrounding the exposure, excess removed peripherally with an excavator, and phosphate cement flooded over the surface; however, this technique is difficult to accomplish without the risk of pressure being exerted over the exposure. (Alternatively, a proprietary brand of calcium hydroxide suspended in methyl cellulose may be used. This is obtained as a sterile white paste, a small portion of which is placed adjacent to the exposure, being carried there on the point of a probe and teased gently across the pulpal wall. After a few minutes this paste dries out and is easily covered with a layer of phosphate cement, placed with minimal pressure.)

Thymozin is a commercial preparation which consists of a block of thymol and a jar of minute pellets composed of zinc oxide particles fused together by thymol.

The thymol is picked up by capillary action, when the closed ends of a pair of heated dressing forceps are placed on the block. When the forceps are opened in contact with the dentine, the liquid thymol floods over the cavity floor. Using a thymozin instrument—a sickle probe with a small metal bead in place of a point—a pellet of zinc oxide is picked up. This adheres to the heated instrument, but

when touched on the cavity floor becomes adherent to the thymol. The instrument is now reheated, and when the pellet is touched with the hot bead it melts and fuses with the thymol to form a hard white brittle mass over the dentine. A layer of phosphate cement can be placed without difficulty upon this base. This dressing acts as a pulp sedative and its use will often result in a complete amelioration of symptoms.

Zinc Phosphate Cement.—It is only too true that familiarity breeds contempt and this adage may be applied to the use or, more correctly, the misuse of phosphate cement.

Since the early days of phosphate cements numerous metallic phosphates have been tried with varying degrees of success, but zinc phosphate has proved to be the safest cavity lining and cementing medium. However, it is necessary to stress the importance of correct mixing whenever this material is used.

In this paper emphasis will be placed on the properties of zinc phosphate cement as a lining material, and its use as a cementing medium will not be mentioned.

The composition of the powder and liquid varies with different makes, but according to Paffenbarger, Sweeney, and Isaacs (1933) the the chief constituent is zinc oxide, although some manufacturers modify their products by the addition of 10 per cent magnesium oxide, and other powders contain small quantities of silica, rubidium trioxide, and bismuth trioxide. The liquid is essentially phosphoric acid containing aluminium phosphate and occasionally zinc phosphate.

The metallic salts act as buffers, slowing down the reaction when the cement is mixed; the water content is critical and the powder and liquid are matched, so it is not advisable to use the liquid of one make and the powder of another.

It is essential that the liquid be kept in a well-stoppered bottle, otherwise the water-content, carefully balanced by the manufacturer, will be altered due to the hygroscopic property of the liquid. This will depend on the difference between the vapour pressure of the atmosphere and the liquid.

Any absorption of water by the liquid will result in a reduction of the setting time and, conversely, a water loss will result in a prolongation; the water loss being evinced as a cloudiness in the liquid due to precipitation of the buffering salts. Such liquid should be discarded.

An exothermic reaction occurs when cement is mixed, and unless the heat produced is minimized and dissipated, crystallization will occur prematurely, thus resulting in a weak cement which has a high initial acidity harmful to the pulp.

In order to overcome this difficulty, the slab should be cooled before use, care being taken that its temperature does not fall below the dew-point of the room, otherwise the water-content of the cement would be altered. The cement should be mixed slowly, incorporating small increments of powder and spatulating thoroughly over a large area of the slab in order to dissipate the heat produced and allow the maximum powder-to-liquid ratio in the final cement.

Manufacturers vary in the mixing times they advise with their particular brand of cement, but it is essential to adhere strictly to the time stated, which is usually between 60 and 90 seconds.

The greater the proportion of powder incorporated, the higher the initial *p*H of the cement and consequently less danger to the pulp. As the setting continues, the *p*H increases to approximately 7, so the greatest damage is likely to occur immediately after insertion.

The writer has formed the opinion, from clinical experience, that a slowly mixed cement, which has the consistency of putty, can be used with safety in very deep cavities. This has been borne out by subsequent vitality tests.

Where the Baldwin technique is to be used, it is advisable to place such a lining over the pulpal wall, prior to using a sticky mix for the retention of the amalgam, otherwise the acidity of the mix may injure the pulp, or amalgam may be packed through into contact with the pulpal wall.

The manipulation of cement is a matter which each practitioner decides for himself, but

many find difficulty when transferring the cement to the cavity because they use excessively large plastic instruments. This results in the placing of cement on the walls of the cavity and over the enamel surfaces.

It is preferable to tease up a pellet of cement on the end of a probe which has been dipped in alcohol, making certain that the pellet is no larger than can be insinuated into the cavity without forcing the walls; then, using a smooth flat-ended plastic instrument (Ash "G" or Porro Special "A"), pack it firmly on to the floor, so as to line, but not occlude, the undercut areas. This may be done with very few sharp taps.

In Class III and Class V "plastic" cavities it has been found that small excavators are admirably suited for insertion of cement linings, especially to ensure that the undercuts are lined. The convex surface of the spoon, either discoid or cleoid, is used to press the cement on to the pulpal wall (*Fig.* 1), then, with the edge of the blade, clear away any cement which may have been expressed on to the periphery of the cavity. Finally a small excavator can be used to ensure that the undercuts are not obliterated by excess cement. It is imperative that the minimal quantity of cement be used, otherwise time is wasted trimming away the excess.

When lining a cavity which has been prepared for a gold inlay, it is necessary, in view of the need to eliminate undercuts, to have the cement slightly more sticky, thus increasing the adhesion and setting time. In Class II cavities difficulty may be encountered in the building of an axial cement wall without re-entrants at the gingival margin. This can be accomplished with ease using a double-ended flat plastic instrument (Ash No. 6), the ends of which have been ground flat and the sides paralleled.

If a copper ring and composition technique is being used it is advisable to defer impression-taking until the next visit in order to prevent fracture of the cement. However, after about 10 minutes, the cement will be hard enough to withstand wax manipulation or the use of rubber base or hydrocolloid impression materials.

If possible all trimming of cement should be done while it is still soft, because when setting is advanced, the crystalline structure is broken up by manipulation. It is safer to wait until initial hardening has taken place before trimming with burs and stones. Any trimming of cement should be carried out at high speeds,

Fig. 1.—Section showing the use of a small excavator for the removal of excess cement from undercuts.

applying minimal pressure and keeping the bur, stone, or diamond constantly moving, so as to avoid producing irregularities in the surface.

The thickness of a cement lining should not be greater than is necessary to insulate the pulp, except where the cavity is of such a depth that an abnormally large restoration would be required. The writer has found that $\frac{1}{2}$–1 mm. thickness of cement will insulate the dentine satisfactorily.

Any excess of cement in a cavity is there at the expense of the restoration, which consequently will be weakened and less retentive. In Class II cavities the cement over the axio-pulpal line angle should be rounded to prevent a concentration of stresses resulting in fracture at a sharp angle in the restoration.

There is no doubt that a restoration can be no better than the sum of the components in its construction; thus a perfect filling must have a hard, well placed lining overlying a

healthy pulp, and be thick enough, in relation to its strength, to endure the force of mastication under all conditions.

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AN INTERESTING DENTIGEROUS CYST

By **J. S. HILTON COLLINGE**, F.D.S. R.C.S.
Consultant Dental Surgeon, Liverpool Dental Hospital and School

A FEMALE patient, aged 50, complained of pain in the temporal and infra-orbital regions. There were no clinical signs and the teeth had been removed fifteen years previously with the provision of full upper and lower dentures. Radiographic examination revealed the presence of two unerupted teeth in the lower left mandibular region, the $\overline{7}$ and $\overline{8}$. The crowns were diametrically opposed with a considerable cystic area and resorption of bone (*Fig.* 1). The area was opened under regional anæsthesia well distal to the $\overline{8}$. The third molar was uncovered, sectioned, and removed together with the cyst lining. The other molar was almost completely covered with bone and at this stage bone was removed to reveal the crown of the tooth. No attempt was made to luxate the tooth owing to the extreme thinness of bone on the inferior border and lingual plate of the mandible. Six months later a radiographic examination showed very good bone regeneration of the cavity and along the inferior border. The $\overline{7}$ was now surgically removed, not without difficulty.

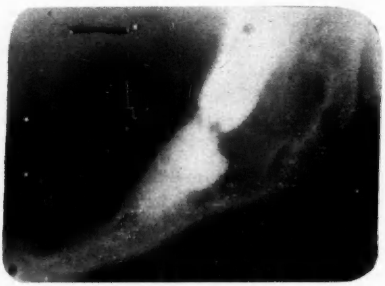

Fig. 1.—Illustrates unerupted $\overline{78}$ with crowns diametrically opposed, with cystic area and considerable resorption of bone.

Fig. 2.—A radiograph taken ten months after the first operation, showing regeneration of bone.

Radiographs taken four months later revealed satisfactory healing and the complete absence of pain (*Fig.* 2).

A.D.A. MEETING, NEW YORK, 1959

For its Centennial Meeting in New York on September 14–18, 1959, the American Dental Association is interested in obtaining motion pictures and scientific exhibits from dentists in the various nations of the world. Individuals interested in presenting a film or scientific exhibit may obtain an official application blank from the Council on Scientific Session, American Dental Association, 222 East Superior St., Chicago 11, Ill., U.S.A.

The Fédération Dentaire Internationale will hold its 47th annual meeting in New York in conjunction with the Centennial Meeting.

THE INTEGUMENT OF THE ENAMEL SURFACE OF THE HUMAN TOOTH

I. THE DEVELOPMENTAL INTEGUMENT

By E. P. TURNER, M.Sc., L.D.S. R.C.S. (Edin.)

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INTRODUCTION

It is a generally accepted fact that when a tooth is affected by caries the process commences at the outer surface, this surface being in contact with the saliva. It follows, therefore, that in a study of the initial carious lesion or the susceptibility of different areas of the enamel surface to caries, consideration should be given to the structures which cover this surface. It has been suggested by Miller (1890), Box (1941), Deitz (1943), and Saunders, Nuckolls, and Frisbie (1944) that these structures protect the surface enamel and that once this protection breaks down the enamel is more susceptible to caries. Rushton (1954) suggests that in the hamster, when a cuticle is present, its destruction (by the bacterial plaque) appears to be a necessary preliminary to fissure caries. Recently Darling (1956) reiterated his previous observation (1943) that the enamel surface may be protected from caries by the "retained enamel cuticle". On the other hand, Leigh (1926) considers that the cuticle may contribute to the initiation of caries by forming a suitable nidus from which the process may commence. In either instance it is important to understand the connexions between these surface structures and the underlying tooth substance, as such connexions may establish inroads along which the caries could advance (Gottlieb, 1947; Manley and Hardwick, 1952; Atkinson and Prophet, 1953).

The presence of a structure covering the enamel surface of human teeth was first described by Alexander Nasmyth (1839); this he called the "persistent dental capsule". Later (1853) Huxley referred to this capsule as "Nasmyth's membrane" and it is probably on account of his recognition of Nasmyth's work that this term has subsequently been adopted (Vallotton, 1945).

Nasmyth considered the membrane to be composed of two layers now referred to as the "inner structureless layer" (primary cuticle of Gottlieb) and "outer cellular layer".

Comprehensive but incomplete reviews of the extensive literature describing Nasmyth's membrane and other enamel cuticles have been written by Vallotton (1943) and Gustafson (1945). It is evident on studying the literature that there is a diversity of opinion regarding the structure, formation, and duration of Nasmyth's membrane on the enamel surface. Other integuments have been described also, such as the keratinous "secondary cuticle" of Gottlieb (1921), and the formation of an "acquired cuticle" on erupted teeth, as suggested by Von Korff (1930), Manly (1943), Vallotton (1943, 1945), Atkinson (1950), Erausquin (1951), Rushton (1954), and Turner (1954 a, b).

In the past some confusion has arisen with regard to terminology. The integument of epithelial cells covering an unerupted tooth will be described as the "reduced enamel epithelium" and the term "Nasmyth's membrane" will be used to describe the developmental structure covering the enamel surface of erupted teeth.

It is proposed in this communication to describe observations on the developmental investments of the enamel surface and in a future communication to describe observations on the "acquired enamel cuticle" of erupted teeth.

MATERIALS AND METHODS

A histological examination of the development of Nasmyth's membrane was made from

developing teeth of man and rhesus monkeys (*Macaca mulatta*). The animal jaws were first radiographed to assess approximately the stage of development of the unerupted teeth. The material was decalcified either in 6 per cent nitric acid and embedded in paraffin wax, or 5 per cent formic acid saturated with calcium phosphate (Brain, 1949). To study Nasmyth's membrane in situ on the crown

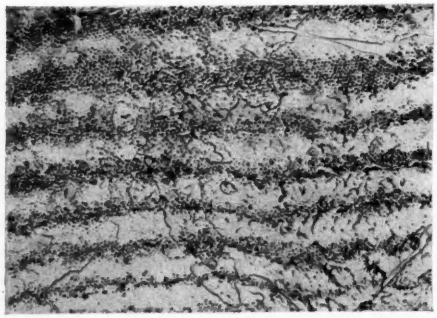

Fig. 1.—Unstained spread preparation of the inner layer (primary cuticle) of Nasmyth's membrane showing the impressions made by the enamel prism-ends grouped together in lines which correspond with the perikymata. (× 60.)

surface of extracted human teeth the method of decalcification and embedding described by Hodson (1952) was employed. Following the application of one of these techniques the tissue was processed and sectioned in the usual way.

Spread preparations of Nasmyth's membrane were obtained by immersing recently erupted human teeth in 2 per cent hydrochloric acid for ten minutes, and lifting the membrane from the enamel surface with the aid of a blunt-ended glass needle under a dissecting microscope; the specimen was then stained in a series of watch-glasses, floated on to a microscope slide, and mounted.

These specimens were compared with the similar structure covering the enamel surface of fully developed unerupted teeth.

RESULTS

1. The Inner Structureless Layer of Nasmyth's Membrane.—After removal of Nasmyth's membrane from a tooth it was found that in many instances not all the inner structureless layer was covered by the cellular layer and there were extensive areas free from cells; it was these "cell free" areas that were used to study the inner layer of Nasmyth's membrane.

This layer is thin. Ussing (1955) estimated it to be usually 200–500Å in thickness. It is not birefringent: it does not readily stain, but

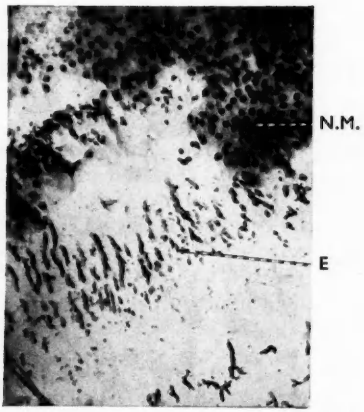

Fig. 2.—Spread preparation of Nasmyth's membrane showing an area of the inner layer on which there are structures which appear to be remnants of epithelial cells (E). N.M., Cellular layer of Nasmyth's membrane. (H. and E.) (× 90.)

is acidophilic and stains lightly with eosin. Consequently it is a structure which is difficult to identify microscopically or to study developmentally. Unstained sections and spread preparations are transparent and amorphous. The latter invariably show impressions of the enamel prism-ends grouped together in lines across the cuticle (*Fig.* 1) corresponding with the perikymata; some areas show markings which appear to be remnants of epithelial cells (*Fig.* 2).

Different authors have attributed the origin of this layer of Nasmyth's membrane to different structures, some of which are summarized below:—

a. The keratinization "or some similar change" of the ameloblasts (Hopewell-Smith, 1919).

b. The cells of the external enamel epithelium (Talbot, 1922).

c. The "inner ameloblastic membrane" of Williams (1923).

d. Fusion of the "cuticular borders" of the ameloblasts (von Ebner, 1922; Chase, 1926, 1929).

e. The fusion of Tomes processes after matrix formation is complete (Nuckolls, Leicester, and Dienstein, 1947).

f. The last formed layer of the enamel matrix (Saunders, Nuckolls, and Frisbie, 1942; Gottlieb, 1921 and 1947; Erausquin, 1951; and Orban, 1957).

g. "Formed by the epithelial cells which happen to lie in contact with the enamel" (Waerhaug, 1956).

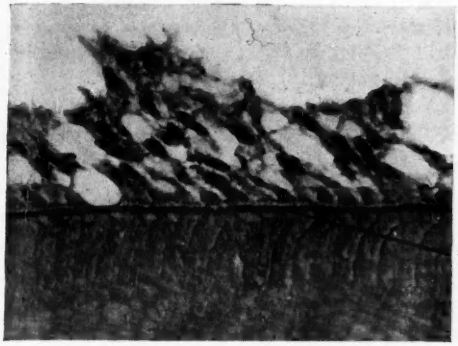

Fig. 3.—Monkey. Section through a developing crown showing the basophilic line (L) on the surface of the enamel matrix. (H. and E.) (× 330.)

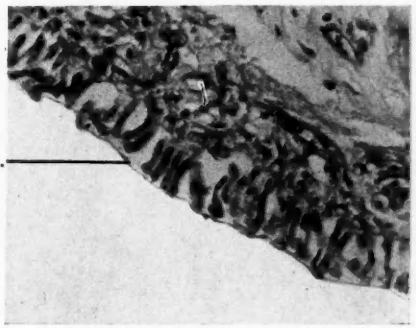

Fig. 4.—Monkey. Section through the ameloblast layer after maturation of the crown of a lower molar. The inner structureless layer of the future Nasmyth's membrane is readily identified due to loss of enamel matrix and shrinkage distortion of the adjacent cells. S.L., Structureless layer. (H. and E.) (× 300.)

Jaccard and Grosjean (1941) and Gustafson (1945) consider that the enamel prism sheaths are composed of the same tissue as this layer; from this, one presumably may infer that they consider it to have a similar origin.

In the present study it was found that longitudinal sections of a developing human tooth prepared from an area where enamel matrix formation is nearing completion show the uncalcified matrix to be basophilic (i.e., the matrix of "unmaturated" enamel). The "cuticular borders" of the ameloblasts and their terminal bar apparatus are clearly defined; Tomes processes connect the basal end of the ameloblasts with the matrix surface. In an area where matrix formation has just been completed the ameloblasts and their connexions present a similar picture. In some specimens at this stage the layer can be identified which will become the inner layer of Nasmyth's membrane (*Fig.* 3). During the maturation process the ameloblasts reduce slightly in length, but the terminal bars and Tomes processes appear to remain unchanged. After maturation has been completed Tomes processes and the terminal bars gradually become less clearly defined until finally they are no longer evident, and the ameloblasts commence to undergo a regressive change (*see below*). Before this stage is reached the enamel matrix becomes soluble in acid, resulting in the absence of matrix in sections of tissue decalcified by routine methods, which allows the inner layer of the future Nasmyth's membrane to be seen more clearly (*Fig.* 4).

Although the mechanism whereby this layer is laid down is not explained by the above observations, it is evident that it does not appear to be formed from the ameloblasts or their processes and connexions, but may be a product of these cells just as the enamel matrix appears to be. Accepting this point of view it is reasonable to suppose that it may resemble enamel matrix in composition. The question of its different solubility in acid, which is frequently encountered, will be discussed later.

Several authors, including Held (1926), Reichenbach (1928), Meyer (1932), Westin (1942), Saunders, Nuckolls, and Frisbie (1942), and Gottlieb (1947), consider that this layer is partly or completely calcified. In sections of enamel matrix with the cuticle in situ, the latter was found to have a variable staining

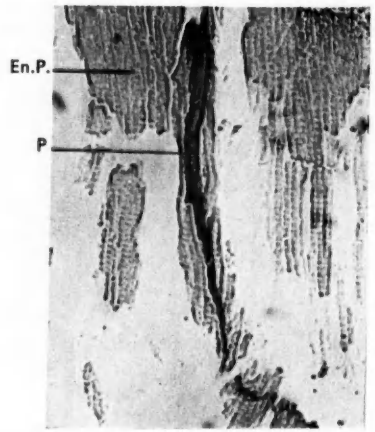

Fig. 5.—A longitudinal section showing a prolongation (P) from the inner layer of Nasmyth's membrane extending into the superficial layer of the enamel. En.P., Enamel prisms. (H. and E.) (× 150.)

reaction, being acidophilic in some instances and basophilic in others. Decalcification techniques used for the preparation of sections of enamel matrix are formulated with the object of preserving calcified organic material. In those cases where the cuticle showed a basophilic staining reaction, it was only when such a technique was employed. It is presumed that in such cases the cuticle was calcified and that if the specimens had been removed from the tooth surface using 2 per cent hydrochloric acid they would have dissolved. Spread preparations of the cuticle obtained by this latter method were never observed to be basophilic. Furthermore, some specimens of this layer dissolved when an unerupted tooth was placed in 2 per cent hydrochloric acid.

From this evidence it is suggested that if the cuticle is calcified it will show a basophilic staining reaction and be soluble in acid, but if it is not calcified it is eosinophilic and relatively resistant in acid.

Bodecker (1927), Fish (1928), and Gottlieb (1947) state that the cuticle is continuous with the sheaths of the enamel prisms. According to others (e.g., Darling, 1943; Nuckolls, Leicester, and Dienstein, 1947), it is continuous with the inter-rod matrix. In this investigation evidence was not obtained of continuity of the cuticle with the prism sheaths or the interprismatic substance. Even with the aid of an electron microscope Ussing (1955) had difficulty in examining the relationship between the cuticle and matrix in human teeth due to loss of matrix during decalcification. However, in unerupted molar teeth in the mouse Ussing found an organic connexion between the enamel matrix and the cuticle.

In the present study it was found that in longitudinal sections of enamel matrix with the cuticle in situ, prolongations extend from the cuticle into the enamel parallel to the direction of the prisms (*Fig.* 5). These appear similar to the "stalactite process" described by Pincus (1944) and the "deeply staining prolongations" described by Butcher (1953). These prolongations, which were observed in many specimens, are thin and occur at irregular intervals. They do not appear to penetrate beyond the "superficial" enamel.

Developmental lamellæ were most commonly found in molars and premolars and are continuous with the cuticle. They pass in a longitudinal direction and are usually confined to the cervical two-thirds of the crown. It is assumed that a lamella present in a fully developed unerupted tooth is "developmental" in origin.

2. The Outer Cellular Layer of Nasmyth's Membrane.—The disagreement between writers concerning the cells which form this layer is evident from the following brief summary of their opinions:—

a. The ameloblasts (Anderson, 1929; Kato, 1929; and Wellings, 1940).

b. The ameloblasts and stratum intermedium (Andrews, 1919).

c. The external enamel epithelium (Hopewell-Smith, 1919).

d. The reduced enamel epithelium (Paul, 1896).

e. The ameloblasts, stratum intermedium, external enamel epithelium together with some connective-tissue cells from the tooth-follicle (Mummery, 1924).

f. The ameloblasts, stratum intermedium, external enamel epithelium, together with some cells from gingival epithelium (Chase, 1926).

g. Gottlieb (1947) considered that if there are cells present, which is not always so in his opinion, then they are derived from the gingival epithelium.

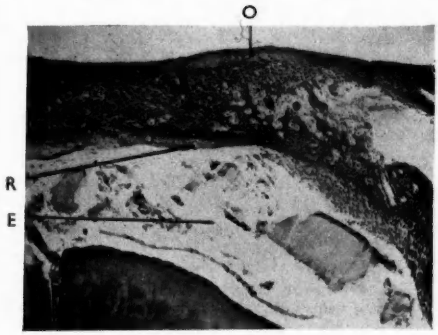

Fig. 6.—Longitudinal section through an erupting human lower incisor tooth showing the incisive edge region where the reduced enamel epithelium (R) has fused with the oral epithelium (O). E is the space occupied by the enamel before the tissue was decalcified. (H. and E.) (× 120.)

h. The ameloblasts, stratum intermedium, and external enamel epithelium (Ussing, 1955). During enamel formation the stellate reticulum reduces in volume as the outer enamel epithelium comes into proximity with the stratum intermedium. Although the cells of the stratum intermedium become less regular they can invariably be distinguished, whereas the cells of the stellate reticulum and outer enamel epithelium lose their characteristic appearance and become identifiable only as epithelial cells. It is difficult, therefore, to ascertain whether the cells of the stellate reticulum take part in the formation of the reduced enamel epithelium or are in fact "lost".

When enamel matrix formation is complete and during maturation of the calcium salts in the matrix, the ameloblasts remain as columnar cells. After maturation is complete, they undergo a process of involution and gradually regress from columnar to squamous cells. Finally the reduced enamel epithelium is composed of 2–4 layers of squamous cells. In agreement with what is generally considered to take place it was found that prior to eruption the reduced enamel epithelium unites with the oral epithelium (*Fig.* 6). As the tooth continues to erupt, this layer breaks down at the centre and the tip of the tooth emerges into the mouth. This connexion between the reduced enamel epithelium and the gingival epithelium forms the "epithelial attachment". Soon after eruption the gingival epithelium appears to grow along the reduced enamel epithelium (that is the epithelium covering that portion of the crown which is unerupted) to form a thicker "combined" layer of epithelium in this region. However, in many of the sections examined there appeared to be a "plane of cleavage" between the two layers which was often characterized by a spacing of the cells (*Fig.* 7). It is suggested that this is where the combined epithelial layer most readily splits. Sections passing through the epithelial attachment at different stages during eruption show that the

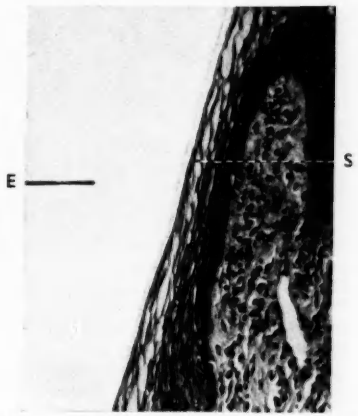

Fig. 7.—Human. A longitudinal section through the epithelium below the gingival crevice of a lower incisor showing spacing (S) of the cells along the plane of cleavage. E, position occupied by the enamel. (H. and E.) (× 180.)

epithelium splits at the base of the gingival crevice along the apparent junction ("plane of cleavage") between the reduced enamel epithelium and downgrowth of oral epithelium, leaving a layer (varying in thickness up to about 4 cells) attached to the enamel surface. This constitutes the cellular or outer layer of Nasmyth's membrane. Below the level of the

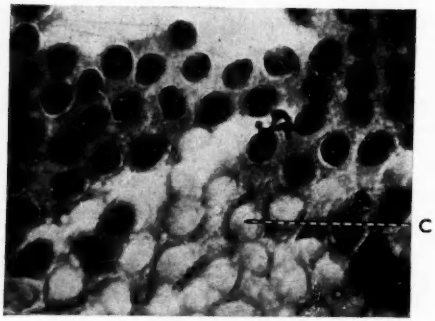

Fig. 8.—Spread preparation of Nasmyth's membrane showing the outline of the cells (C) after the nucleus has disappeared. (H. and E.) (× 400.)

gingival crevice the epithelium appears to be in close connexion with the enamel surface, and the point of cleavage referred to above is confined to the crevice. In agreement with Waerhaug (1952) and Ussing (1955) it was found that the truth of this statement is not supported by clinical examination of the gingival pocket around erupting teeth. Around such teeth the distance from the base of the pocket to the incisal edge or surface invariably corresponds with the height of the anatomical crown of the tooth examined. This indicates that along the unerupted part of the crown of a partially erupted tooth there is only a weak union between the cells along the plane of cleavage, or no union, from the amelo-cemental junction up to the level of what appears histologically to be a shallow gingival crevice.

CHANGES IN THE CELLULAR LAYER

No evidence was observed of keratinization of the cellular layer of Nasmyth's membrane as reported by Hopewell-Smith (1919) and Fish (1952). In this connexion Gottlieb's secondary "horny" cuticle will be discussed in a subsequent article.

Spread preparations of Nasmyth's membrane, stained with hæmatoxylin and eosin, show that the cell nuclei of this layer become vacuolated and granular, having presumably lost their source of nutrition; in many instances

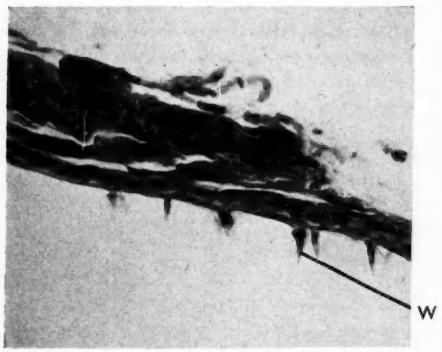

Fig. 9.—Section through the reduced enamel epithelium which demonstrates the wedge-shaped processes (W) extending into the enamel surface. (H. and E.) (× 300.)

the nuclei degenerate, leaving only the cell outline, and present the unusual appearance shown in *Fig.* 8. In contrast, no evidence of degeneration of the cells of the reduced enamel epithelium was observed unless the specimen was obtained from the tooth of a patient advanced in age. In such cases it was sometimes found that the reduced enamel epithelium incompletely covered the enamel, resulting in changes which are described below.

THE RELATIONSHIP OF NASMYTH'S MEMBRANE TO THE ENAMEL SURFACE

Nasmyth's membrane was observed to penetrate the enamel surface in a manner similar to the "pear-shaped depressions" of Malleson (1925) and the "wedge-shaped defects" of Hodson (1953) (*Fig.* 9), the incidence of these defects being highest in molars. The membrane also occupies the hypoplastic pits described by Hodson (1950) as "tubular hypoplasia" (*Fig.* 10). These minute pits occur most commonly on the occlusal surface of molar teeth or as an

extension to the deepest part of an occlusal groove towards the amelo-dentinal junction. In many specimens such a pit is found on the buccal surface of lower molar teeth which

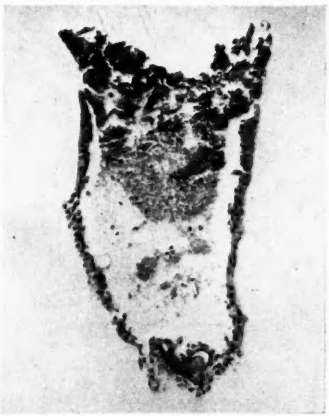

Fig. 10.—Human. A longitudinal section through a tubular hypoplastic pit obtained from a recently erupted tooth. Nasmyth's membrane can be seen lining the walls of the pit, which is occupied by cell debris. (H. and E.) (× 180.)

may account for the relatively frequent occurrence of caries at this site.

No evidence was obtained concerning the attachment of Nasmyth's membrane to the enamel surface other than the connexions described above, or the attachment of the outer cellular layers to the inner structureless layer. Ussing (1955) points out that this is not possible using the optical microscope.

Fig. 11.—Showing extension of cementum formation over the enamel (E). (H. and E.) (× 270.)

Toller (1948) and Butcher (1953) consider there is a strong bond between these layers.

FUNCTION

The function of the reduced enamel epithelium in the formation of the epithelial attachment has already been described and is well known.

In unerupted teeth the reduced enamel epithelium appears to have a protective

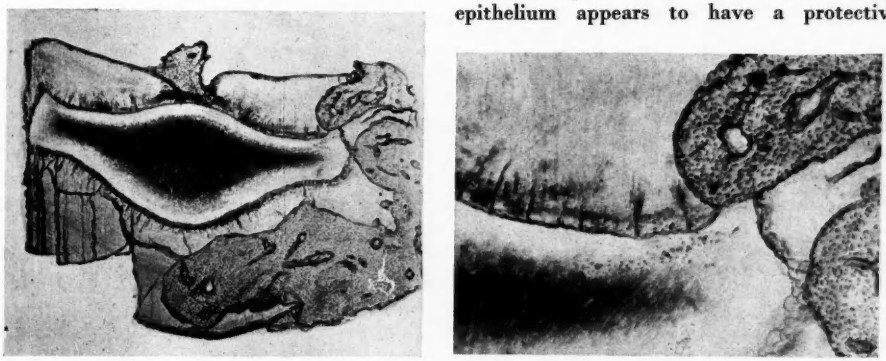

Fig. 12.—Transverse section through the crown of an unerupted lower canine removed from a patient aged 80 years. The enamel and dentine have been partly resorbed and replaced by bone. A, Low power. (× 60.) B, High power. Ground section. (× 150.)

function. If this layer of cells is deficient two changes may occur:—

1. If the deficiency is in the cervical region of the crown "exposing" the enamel, cementum may be laid down on the enamel surface (*Fig.* 11).

2. The enamel may be resorbed. This resorption has only been found in unerupted teeth removed from patients later in life (*Fig.* 12).

It is suggested that the cellular layer of Nasmyth's membrane is a layer of cells which remain attached to the enamel surface after eruption, and having performed the functions already described they are at this stage redundant, shortly to be removed by the trauma of mastication.

There is disagreement between writers concerning the function of the inner layer of Nasmyth's membrane and the length of time that this layer remains on the enamel surface. This point will be discussed in Part II of this article, which will appear in the August issue of this JOURNAL.

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Aphthous Ulceration of the Mouth

A simple, safe, and effective method of treating painful aphthous ulceration of the mouth is described. A tablet containing 2·5 mg. of hydrocortisone in the form of its hemisuccinate sodium salt—a water-soluble compound—is allowed to dissolve slowly in the mouth. It is necessary that some contact between the tablet and the ulcer must be maintained. The use of antibiotics is strongly deprecated as being dangerous. The authors have been impressed by the mental disturbance created by the major form of aphthous ulceration and by the improvement in mental well-being when treatment is effective.

Treatment has been given to 52 patients, all of whom have shown marked degrees of relief from pain. Four tablets a day has been the maximum dose, a dose unlikely to have any harmful systemic effect, however long continued.—TRULOVE, S. C., and MORRIS-OWEN, R. M. (1958), *Brit. med. J.*, **1**, 603.

BOOK REVIEWS

CLINICAL PROCEDURES IN OCCLUSAL REHABILITATION. By S. CHARLES BRECKER, D.D.S., F.A.C.D. 10 × 7 in. Pp. 326 + viii, with 428 illustrations. 1958. Philadelphia and London: W. B. Saunders Co. 112s.

ON both sides of the Atlantic Charles Brecker is known as a lecturer and clinician on porcelain jacket crowns. His book on the subject has become a classic because of its practical and commonsense approach to a difficult and specialized branch of dentistry.

Clinical Procedures in Occlusal Rehabilitation does not maintain the same high standard, but nevertheless it is a book of great practical value to anyone interested in modern methods of oral rehabilitation. Dr. Brecker writes with an easy style. He explains the difficult techniques with a simplicity born of a thorough understanding of the subject. He describes in detail the various techniques that are used in his surgery and laboratory, They are obviously the sum of many years of experience and therefore worthy of careful study.

Dr. Brecker does not fall into the usual trap so often to be found in books of this nature where authors recall many of the older familiar techniques. He has always been in the forefront of practitioners who try out every newly available material, and, as a result, describes the use of some of the more effective ones in detail. Among these, he discusses the use of the rubber base impression material for impressions which, when silver plated, give a hard-surfaced working model. Elsewhere there is an interesting description of the recently developed porcelain which is directly fusible to gold. Dr. Brecker, who has always felt that æsthetics were an integral part of dentistry, devotes considerable space to showing how best this can be achieved, by means of both partial dentures using internal attachments and crowns and bridges.

Two important criticisms which might be levelled at this book are, firstly, the omission of any discussion of occlusal grinding, and, secondly, no mention is made of the inlay as a restorative medium or bridge abutment. Brecker is an enthusiast for full coverage in conservative treatment. One may, however, be justified in feeling that it is carried a little too far at times.

The second half of the book is devoted to a review of a considerable number of cases that have been treated by the author. Photographs of every stage are shown. This serves two purposes: to show the practical possibility of his methods of treatment and to illustrate an ingenious and useful classification that Dr. Brecker has devised for occlusal rehabilitation cases.

It is rare to find a book with so many photographs and illustrations with such clarity and value. Notwithstanding earlier remarks in this review, there is much of interest to the advanced practitioner of conservative dentistry.

A recurring point stressed by Dr. Brecker is that this type of dentistry demands a great deal of time on the part of the dentist and patient. Because, therefore, of the associated delicacy of work it is necessarily very expensive. This economic factor is becoming a problem the world over in the development of advanced dental techniques.

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PHARMACOLOGIE ET PHARMACOTHERAPIE DENTAIRE. By O. NOEPPEL, Docteur en Médecine, Chirurgien-dentiste. $9\frac{3}{4} \times 5\frac{3}{4}$ in. Pp. 354 + viii. 1958. Paris: Masson & Cie. 3500 francs.

THIS would be a handy reference book for any practitioner interested in a condensed account of the general effects of the drugs he uses, and of some he does not. It has drawbacks: it is dogmatic (although names are occasionally cited, there is no bibliography whatsoever), it is not cheap, and it is in French. However, it is perhaps the most useful textbook of specifically dental pharmacology to appear for some time.

C. R. B. J.

PRINCIPLES OF COMPLETE DENTURE PROSTHESIS*

By CHARLES H. JAMIESON, D.D.S., *Detroit*

THE study of the complete denture problem has expanded greatly since the turn of the century. Research into the intricacies of allied sciences has broadened our understanding of the complex masticating mechanism and brought a new awareness of its importance to the well-being of the total body. We recognize that at the other end of a tooth is a man.

Principles of complete denture prosthesis can be considered logically under three headings, all closely related. These are the psychological phase, the physiological phase, and the biomechanical phase. It would be difficult to state which is of greater importance, for knowledge of each is necessary to an understanding of the whole. Their correlation in practice can restore masticating efficiency and comfort to the patient and bring a sense of satisfaction in accomplishment to the dentist.

THE PSYCHOLOGICAL PHASE

This begins with the patient's first visit and the initial consultation. Psychology is that branch of science which treats of the mind and mental processes, especially as shown in behaviour. The consultation is a two-way circuit in which the dentist is observing the behaviour of the patient and at the same time the patient is observing the dentist. The importance of the consultation in establishing rapport cannot be under-estimated, for the confidence of the patient in the ability of the operator to achieve a satisfactory result is the first step towards success.

Inquiry into the past dental experiences of the patient will divulge his attitude toward dentistry as a whole and his own dental health in particular. If he is edentulous, for how long; if now wearing dentures, with what satisfaction; what is expected of new dentures; is he sensitive or tolerant; critical or sceptical; apprehensive or confident? Such questioning permits the dentist to catalogue mentally those characteristics of the patient which will influence his future treatment.

The diagnosis may disclose problems which may be difficult to solve and may tax the patience of both operator and patient. He who has been unhappy with several sets of dentures may present the same anatomical problems as he who has been pleased with one. The treatment plan for the former must be more exact in detail from both physical and psychological aspects to attain success.

Psychological Aspects of Ageing.—Fitting the personality of the aged patient is often more difficult than fitting the denture to the mouth. The vague pains and annoyances common to many patients are exaggerated in the aged. The mental quirks and character deficiencies associated with senility are roadblocks for the prosthodontist. Patience and understanding are necessary in the treatment of the patient whom we too frequently dismiss as neurotic.

Elderly people develop fixed habits and ideas and do not adapt readily to change in mode of life. They tend to endure increasing physical discomfort rather than make the effort to seek early treatment of an ailment which may become serious.

Those who have worn dentures for a long time and who have gradually become accustomed to juggling dentures which have long outlived their usefulness may object to an increased vertical dimension and close adaptation of corrective dentures. As senescence progresses, neuromuscular co-ordination is decreased, often as the result of cerebral accidents of varying degree. This disturbance of normal function gives rise to difficulties in chewing, swallowing, and speaking. The insertion of dentures which are intended to correct acquired mal-relations of the jaws and oral structures are an added source of annoyance. An evaluation of the ability of the

* A paper delivered to the American Dental Society of Europe, August 28, 1957.

patient to accept major improvements in function determines how far we can go towards the ultimate in correction. Recognition of the problems tends to reassure the patient that the dentist will use all the knowledge and methods available to provide comfort and service. Questions must be answered honestly and sincerely and promises must not be made if their fulfilment is uncertain. Many patients are very interested in each step of the procedure. Others care not at all but attempt to shift the entire responsibility for the success of the undertaking upon the dentist. The patient must clearly understand that complete co-operation throughout the treatment period is necessary, and that success is impossible without his help. The unco-operative, demanding patient should not be accepted, for failure is invited.

Prosthodontists agree quite generally that the transition from the dentulous to the edentulous stage is accomplished more easily and successfully by the immediate denture technique. Its advantage from an æsthetic standpoint is an important psychological factor in the acceptance of the dentures by the patient concerned with ultimate appearance. When informed of the advantages of this technique and the elimination of the edentulous period which might remove the patient from normal social contacts, relaxation and an expression of relief are often noted in the worried patient. Study casts made from impressions of the natural teeth and photographs provide a visual means of assuring the doubting patient that duplication of size, shape, colour, and arrangement is possible if desired, and alterations can also be made by agreement to correct gross deformities where advisable without losing individual characteristics. The patient's fear of extreme soreness if dentures are inserted on surgerized ridges is readily dispelled when the denture is likened to a bandage placed over injured tissue.

The psychological phase carries through the entire construction and adjustment periods. Instruction and explanation in the care and use of dentures should be continued with each appointment. An instructed young patient will make the transition from natural to artificial dentition more easily than the oldster who may require a longer period of adjustment and training.

The influence of psychology upon human behaviour is well expressed by Alexis Carrel (1935) when he says: "The shape of the face, the mouth, the cheeks, the eyelids, and the lines of the visage are determined by the habitual condition of the flat muscles which move in the adipose tissue underlying the skin. The state of these muscles depends on that of our mind. Indeed, each individual can give his face the expression that he chooses."

THE PHYSIOLOGICAL PHASE

The physiological phases of complete denture prosthesis have to do with the functional aspects of the artificial appliances. While the restoration of masticating function is a prime object, the correlation of this act with the accessory oral functions such as speech and deglutition is just as important. Evidence is accumulating that normal function is best attained by restoration of lost form and contour, and a duplication of structures as they were before break-down and retrogression of function began.

The relationship between the physiological age and the chronological age of the patient must be considered when function is discussed. The resultant effect of the passage of time on the functional elements of the body is exceedingly variable. A man aged 65 may have the mental alertness approximating age 50 but a masticating mechanism age 75. Bortz (1955) states that the rate of change is influenced by toxic agents in the body and adverse hereditary influences.

Physiologically all oral tissues are affected by the ageing process. The jaws, teeth, mucous membranes, salivary glands, and associated anatomical structures undergo a gradual retrogressive change as the result of a decrease in the metabolic activity of the individual cells. This impairs the function of all tissues and organs and results in atrophic reactions to stress and irritation, rather than the stimulating productive reaction typified in youth.

One of the most common complaints of the elderly denture patient is traumatic mucosal irritation. Massler (1956) states that this is due mainly to the friability of the tissue, caused by dehydration of the mucosa, together with a gradual thinning of the epithelial layer. Progressing age makes the mucosa susceptible to even minor irritating stress. It loses elasticity and appears shiny and pebbly. Burning sensation of the tongue and lips and abnormal taste, such as salt and sour, are frequently noted, especially in the post-menopausal period. Eighty per cent of females at this time present this complaint, which is also associated with a decrease in salivary flow causing a dry mouth. These conditions may combine to create tenderness which interferes with the wearing of any removable denture.

The atrophy of oral structures in ageing is progressive and the gradual change in the supporting bone induces the closing of jaw relations, strained temporomandibular structures, and shifting of the dentures on their bases. The early loss of posterior teeth without replacement and dependence upon the anterior teeth for function during the advancing years is quite commonly found. The maxillary teeth are usually the first to be lost, followed by the lower posterior teeth, and a breakdown of the anterior maxillary ridge is the consequence when opposed by the natural anterior mandibular teeth in premature contact.

The prosthodontist is given the opportunity of correcting the accumulated abuses which the masticating mechanism has suffered through the gradual loss of teeth, periodontal disease, and improper habits of chewing. Temporomandibular joint dysfunction is often the end result of these abuses. Complete dentures can either perpetuate the deformity or be corrective in function, dependent upon the dentist's ability to create a mental picture of the structures before destruction occurred. The interrelation of functioning of the temporomandibular joint with the muscles, ligaments, nerves, joint structures, and the teeth puts an emphasis on the patient as a unified whole.

Vertical Dimension and Centric Relation.—Ideally dentures should be made to conform to the patient's physiological pattern of mandibular movement. This pattern is dependent upon centric relation and the physiological rest position. We accept the definition of centric relation as that relation of the mandible to the maxilla, at any given degree of jaw separation, when the condyles are in the most retrusive position in the glenoid fossæ from which lateral movements can be made. To find this pattern, it is first necessary to record the physiological vertical rest position, which may be defined as that position assumed by the mandible when all muscles associated with masticatory function are in a state of balanced tonicity. The problem is to find that position and record it consistently, and much research has been devoted to this phase of denture technique.

In the rest position the teeth are not in occlusion and the space between the upper and lower incisors may vary from 2 to 10 mm. or more. This interocclusal distance (free-way space) varies in a degree proportionate with age and natural abrasion of teeth through occlusal wear. To record this position, the patient must be completely relaxed. If relaxation is difficult to obtain, a sedative, in the form of a barbiturate, may be administered.

A simple technique for measuring the vertical dimension of rest position is to make dots with a pencil or to place small triangles of adhesive tape on the tip of the nose and on the tip of the chin where the tissue is firm. These serve as reference points for measurements. The patient must be seated upright in the chair in a normal sitting position. He is directed to moisten his lips with his tongue, to swallow, and then to relax at the completion of the swallowing act. The distance between the dots is measured with a millimetre scale or dividers at this time. This procedure is repeated until the measurement can be duplicated consistently. Separate the lips to note the approximate space existing between the teeth or ridges at the end of the swallowing cycle. The patient may be asked to hold the mouth open wide for a time, which will tend to tire the muscles, and thereby assist him to assume a relaxed position of the mandible

more easily. It may be necessary to instruct some patients and have them practise relaxation at home before the next appointment. Unless the rest position measurement is the same when it is repeated, it should not be accepted for guidance in determining centric relation and vertical relation. Atwood (1957) concludes that dependence upon a single factor in determining vertical dimension is unsafe since anatomical, functional, metabolic, and prosthetic factors all influence the rate of resorption of the edentulous ridge. Because of the complex character of the neuromuscular system, there can be balance between antagonistic muscles at a number of different muscle lengths and tones within certain physiological limits.

The influence of muscle action on mandibular position has been graphically demonstrated by the use of electromyography. This has made it possible to study the complex neuromuscular system as it relates to individual and collective muscle action. While not practical for routine use, it enables us to understand more fully what the muscles are doing. The degree of activity of the muscles which produce the functional and non-functional movements of the mandible can be recorded. For example, it can be demonstrated that the external pterygoid muscles are most active in the opening movement, and that the suprahyoid muscles are also very active. This has been shown by Hickey, Stacy, and Rinear (1957). In the same movement, the temporal and masseter muscles show little activity. Perry (1957) has also demonstrated that physiologic rest position can be determined by electromyographic records. "When a healthy, normally innervated, voluntary muscle is at rest, there are no signs of activity recorded by surface electrodes. Should the slightest movement occur or the least bit of contraction take place, however, electrical discharges are 'picked up' by the surface electrodes." Harris, Mayers, Jarabak, and others have also contributed to this field of research.

With the use of the "Bimeter", Boos (1940) found that the greatest biting pressure was at the vertical level of rest position. It has been stated that the rest position is constant throughout life, but it seems that practical clinical experience refutes this contention. Mandibular position is dependent upon a three-dimensional equilibrium of its associated musculature. With the normal change in muscle tonus as age progresses, there is a relaxation or a "sagging" of facial muscles, and it seems logical to assume that the muscles which control the position of the mandible would also undergo a physiological change in function and structure, altering the relation of the mandible to the maxillæ in rest position. When complete dentures are being made for a patient 65 years of age, we have no way of knowing what his physiological rest position was at the age of 20. The position is recorded as we find it, and when checked and rechecked it is accepted as accurate. Often a compromise must be accomplished, and a centric relation established in harmony with existing factors.

If we accept the contention that youth maintains an interocclusal distance of 1·5 or 2 mm. and that ageing increases this distance by attrition and bone change, a centric relation can be accepted which will decrease the vertical dimension 2–4 mm. from the recorded rest position, and thus permit freedom in speech and more normal deglutition. If there is need to decrease the muscular stresses upon the ridges to reduce trauma, the vertical dimension should be decreased proportionately.

The centric relation at the selected vertical dimension is transferred to the articulator with stabilized base-plates and occlusion rims and with a face-bow registration. Centric relation is rechecked with the teeth set-up at the try-in stage and balance in all ranges of movement observed.

At this time the effect of tooth position on speech and deglutition can be studied. With the patient relaxed in an upright sitting position and the trial dentures in place, the patient is told to close lightly and swallow. With the previous training for making the centric relation registration, centric position should be assumed readily. In conversation, the patient is asked if the posterior teeth were striking. Assuming that the dentures are stable, if clicking was continually noted the relation should be decreased and a greater

free-way space must be provided. If swallowing is difficult the relation may be too closed, restricting tongue movement. Observing the tooth position in speech in profile, the incisal edges of the maxillary and mandibular teeth should approximate in protrusive movements. The denture teeth should be set to reproduce natural tooth position if possible. However, in badly mutilated mouths the mechanics of function cannot be ignored. For a patient with an extreme vertical overbite, some prosthodontists believe that protrusive balanced occlusion is not necessary and sacrifice function for æsthetics. In this instance a compromise must be made, and the normal contours altered as little as possible.

Deglutition.—The first physiological oral function is sucking and swallowing. In the infant, this is an instinctive primary act of co-ordination of all oral structures. The force exerted in this stimulating function is vital in the development of the eventual masticating mechanism. The muscles, bone, tongue, salivary glands, and all oral tissues respond and develop dependent upon the continuance of sucking and swallowing during the growth period. With the development of the dentition, the rapid rhythmic swallowing of the infant is altered somewhat and becomes more of a two-stage function. In swallowing saliva, for example, there is first a contraction of lips and cheeks against the labial and buccal surfaces of the teeth and the tongue is raised in the vault of the mouth, with its border in close contact with the lingual surfaces of the teeth.

We can recognize a difference in the normal act of swallowing saliva and in drinking a beverage or in swallowing food. Repetitious swallowing of a beverage does not require contact of the teeth. It seems to be a one-stage function. Frequently in swallowing food, particularly if it requires repeated swallowing, the teeth may not occlude except at the conclusion of the act. If this is done involuntarily, the teeth are in centric occlusion. If swallowing is consciously voluntary, the teeth may not be in centric occlusion: thus an error may be made if swallowing is used as a guide in registering centric relation. The second stage completes the act with the relaxation of muscular tension and a dropping of the mandible to the physiological rest position. Since we swallow every 60–75 seconds involuntarily, the importance of correct centric occlusion to maintain stability of dentures is emphasized. As age increases we become rather lazy swallowers, and the stimulation of the salivary glands which vigorous swallowing produces is lost.

Wright and Kingery (1949) have demonstrated the influence of tongue position in the retention and stability of the mandibular denture, and shown the correlation between the act of swallowing and tongue position. A patient with a normally retruded tongue can be trained to keep the tongue forward in light contact with the lingual surface of the denture and in swallowing create a seal which greatly assists in maintaining the position of the lower denture. Physiological patterns can sometimes be altered by training, and by repetition become valuable aids in function.

THE BIOMECHANICAL PHASE

The biomechanical phase is that which correlates the technique of construction with the anatomical and physiological factors to produce a functioning prosthesis for the edentulous patient.

Impressions.—One of the first steps is the procedure for making the impressions. Modern impression techniques are numerous, but may be generally classified as to jaw position and the degree of pressure, non-pressure or selective pressure. Presently the open mouth technique has the greater number of advocates, and the non-pressure or selective pressure techniques are widely used. There can be no universal impression technique which can be applied to all patients, but there can be a basic technique for what is termed an average patient. This technique should be capable of revision depending upon the anatomic variations which examination of the mouth reveals.

On a cast made from a preliminary impression of each individual patient, a rigid durable tray can be made in a few minutes with an autopolymerizing plastic, or from a thermoplastic material which is easily adapted with

a Bunsen flame. This close-fitting tray can be tried in the mouth, and the borders can be trimmed to permit freedom of all muscle movements. The borders can be adapted accurately with stick modelling compound to conform to the functional movements of the border structures to perfect a seal without displacement of these structures. The impression is completed with an easy-flowing zinc oxide and eugenol paste to register the fine detail in the contours of the supporting structures.

This technique provides a control of the tissues in both the hard and the soft areas. Hard areas or knife-edge ridges are relieved by scraping the preliminary impression before the plaster cast, for making the tray, is poured. Soft, resilient, or flabby areas or knife-edge ridges are reproduced in their normal position without distortional pressure. The aim of this selective pressure technique is to produce an impression which permits equal distribution of masticatory stress upon all of the supporting tissue.

Base Plates and Occlusion Rims.—Casts of artificial stone are made and shellac base-plates adapted. Because of the warpage often found in using these base-plates, they are lined with zinc oxide and eugenol paste for greater stability in use. If the casts are moist the lined base-plates can be readily removed without sticking. The paste is not applied to undercut areas. Hard wax occlusion rims are adapted to the base-plates. To allow some excess for trimming, the upper rim is built approximately 22 mm. in height from the upper labial sulcus and 8–10 mm. in the molar region. The lower rim is built about 18 mm. in height from the lower labial sulcus and to the height of the retromolar pad in the molar region. The total 40 mm. of vertical height is altered in the mouth dependent upon the individual vertical dimension selected as discussed earlier in this paper. The labial and buccal surfaces of the occlusion rims are shaped to reproduce the contours of the teeth and tissues before extraction and resorption. The lingual surfaces are contoured to conform to the lingual margins of the ridges.

The Face-bow.—After vertical dimension and centric relation are determined, the registration is transferred to the articulator by means of the face-bow.

The face-bow is recognized as an important aid in the orientation of casts on an articulator in a position approximating that of the maxillæ and mandible to the temporomandibular joint. The degree of approximation is dependent upon the accuracy of transfer technique.

Several hinge-axis face-bows have been devised for locating the rotation centres of the condyles. When used correctly this technique is of proved value. In practical application, however, the arbitrary technique of transfer as advocated by Hanau with face-bow model "C" is acceptable. The location of the axial centre of the condyle is determined by an average measurement of half an inch anterior to the centre of the tragus of the ear, in line with the corner of the eye. A pencil dot is made at this point, and it is used to locate the condyle rod of the face-bow on the face.

The fork of the face-bow is attached to the upper occlusion rim. The base-plates must be stable in the mouth. The condyle rods are centred over the dots with equal calibrations on each side, and the adjustment screws are set. I prefer to mount the upper cast prior to registering centric relation, but both procedures can be done at the same time if desired.

A small ball of very soft beeswax, or a wax of similar consistency, is placed in the notches in the wax rims on each side, and the patient is told to close lightly, as before, until the occlusion rims are within 1 mm. of contact. This uniformly softened wax seats the base-plates on the ridges with equalized light pressure and avoids a distortion which might occur if the hard wax rims were to touch. The rims are fastened together with staples or with a warm spatula and are removed from the mouth without distortion.

This method of registering centric relation is one of several which can record the maxillo-mandibular relation accurately. Through the years I have tried all techniques, including those which employ various types of central bearing points and needle point tracers, but for simplification and uniform results the method described is preferred.

Tooth Selection and Positioning.—In the selection of anterior teeth, pleasing æsthetics is the first consideration. Æsthetics are influenced by the size and shape of the anterior teeth, their colour and arrangement. Selection should not be made until the vertical relation has been determined with the occlusion rims in position, when facial contours are more nearly normal.

Frush and Fisher (1955) have brought to our attention, through the Swissedent Foundation, the interesting work of Wilhelm Zech of Zürich, and suggest that sex, personality, and age of the patient be considered as essential factors in tooth selection. This approach to æsthetics revives our interest, even though these factors have not been entirely ignored in the past.

The sex and personality of the patient should combine to determine the boldness or the mildness of the æsthetic treatment. The size and shape of the anterior teeth must harmonize with the lips which frame the teeth in smiling and speaking. The sex of the patient is not the determining factor in size selection, but it is more likely to influence the shape and position of the teeth. The male patient usually requires the more severe arrangement. The age of the patient is important in colour selection and tooth positioning. As years pass, attrition, injury, and repair affect the colour of teeth individually, and with relation to each other in arrangement. Skin textures change with the years also, and harmony of teeth and their supporting tissues produces pleasing æsthetics. The reshaping of teeth and the blending of harmonious shades do much to disguise the artificiality of tooth positioning. The use of immediate denture service, with its many æsthetic and psychologic advantages, has focused attention on the accurate reproduction of natural tooth position in complete dentures.

Pound (1951) believes that four principles of natural arrangement should be followed:—

1. The occlusal plane should be parallel with the floor when the patient is standing or sitting erect.

2. There should be a clearance of 1 or 2 mm. between the upper and lower anterior teeth when the "S" sound is produced.

3. The correct amount of tongue space should be provided by placing the lingual surfaces of the lower posterior teeth in line with the lingual border of the retromolar pad.

4. The natural position of the tooth with relation to the ridge should be duplicated.

The old rule that teeth should be set on the crest of the ridge has often resulted in closed relations and poor æsthetics. Natural tooth positioning should be the rule unless extreme anatomical variations demand a compromise.

Posterior Teeth.—The relationship and shape of the upper and lower ridges and the anticipated forces that may be exerted upon them determine the posterior tooth selection. Ridge relations must be considered in both vertical and horizontal positions. The ridge shape may be normally rounded, flat, knife-edged, or a combination of these.

A cusp tooth, or a modified cusp tooth, should be used when ridges are normal or near normal in shape and relation to each other, when æsthetics demand a deep vertical over-lap, and when the muscle tonus is average.

The cuspless tooth, or non-anatomic tooth, should be used when the ridge relation is abnormal, when the ridge is flat or knife-edged, and when muscle tonus is weak.

The maximum in masticating efficiency and comfort can be achieved only by the proper evaluation of these diagnostic factors. In my opinion, the normal patient will be more satisfied with the modified anatomical porcelain tooth. In some cases, plastic teeth are more comfortable and æsthetic but less efficient.

Usually, the lower ridge must be favoured when positioning the teeth and be given every advantage in leverage and mechanics. Therefore, it seems logical to set the lower teeth first, approximating the natural tooth position as closely as the anatomic variations of the ridge will permit. Teeth set at right angles to the ridge will result in greater stability. Ridges that are short anteroposteriorly frequently require the omission of a bicuspid or a second molar, especially if excessive resorption has produced a ridge that rises abruptly

in the second molar area. The upper teeth are set in occlusion with the lower teeth and balanced in all ranges of movement. Continued stability of denture bases cannot be maintained without balanced occlusion.

Centric relation, balanced occlusion, and rest position are checked and rechecked when the positioned teeth are tried in the mouth. A protrusive wax record is made and the condyle adjustments on the articular set and the teeth re-balanced if necessary. The patient's approval of the appearance is important before continuing with the finishing. The staining, tinting, and colour impregnation now being used to improve the appearance of synthetic resins have eliminated the fear of showing unsightly base material.

Remounting for Equilibration of Occlusion.—The dentures are remounted on the articulator after processing. They are deflasked carefully, and left on the casts with their keyed bases, and thus can be put on the articulator in the original mountings. By this procedure any discrepancies in occlusion which may have occurred during processing may be checked. Centric occlusion is checked with blue articulating paper, and the protrusive and lateral occlusions with the original condylar inclinations are checked with red articulating paper. A cusp that is marked with both blue and red is adjudged to be correct, and the opposing sulcus is ground sufficiently with a small stone to achieve balance. The contacts made by each tooth are checked in various positions, and they are carefully ground to produce a balanced occlusion with the functional range of movement. The upper and lower anterior teeth should make contact in protrusive and lateral positions only, with the posterior teeth maintaining balancing contacts in centric occlusion as well as in protrusive and lateral occlusions. Milling with abrasive paste is done lightly only to perfect the balance after the major equilibration has been done with small stones in a handpiece. Indiscriminate milling will reduce the height of cusps excessively and tend to reduce the occlusal vertical dimension and destroy the balance in lateral occlusion. Occlusal adjustments made in the mouth should be limited to the elimination of minor discrepancies. Instability of the bases on varying hard and soft tissues of the ridges make major occlusal adjustments in the mouth hazardous.

After the dentures are ground-in on the articulator, the final polishing is done in the laboratory with insistence that the borders be finished exactly as indicated in the impressions. If the waxing and contouring have been done carefully, little polishing is required.

The dentures are delivered and the instructions previously given are reviewed. The patient is given a denture brush and told how to use it. An appointment is made for observation and any necessary adjustments. The importance of periodic examinations is stressed and our interest in the patient's welfare emphasized.

The degree of success enjoyed by the patient is dependent upon our interpretation of the psychological, physiological, and biomechanical factors encountered during the treatment period.

As in any worth-while endeavour, prosthodontics demands the exercise of good judgement. Good judgement comes from experience, and experience comes from poor judgement. The errors of the past are the safeguards of the future.

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A NEW METHOD OF CEPHALOMETRIC ANALYSIS SUITABLE FOR THE DIFFERENT CONSTITUTIONAL TYPES OF HEAD

By Prof. **GIORGIO MAJ**, Dr. **CESARE LUZI**, and Dr. **PAOLO LUCCHESE**, *Bologna, Italy*

RESEARCHES on the morpho-topographic variability of the cranio-facial frame have led us (Muzj, Maj, and Luzi, 1955) to distinguish, according to the difference in the fronto-facial profile angle, three normal skeletal types, named prognathic, mesognathic, and orthognathic, each of which is characterized by special ratios among the various parts which compose the head and by a typical behaviour of the principal anthropological planes (*Fig.* 1).

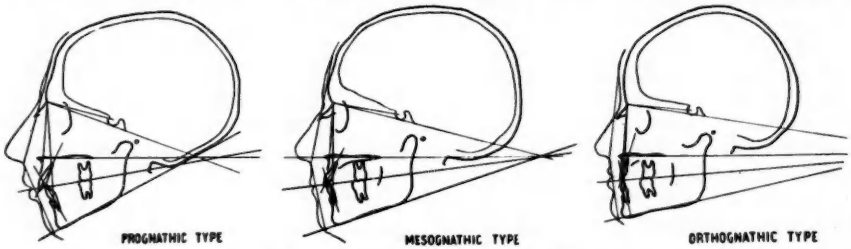

Fig. 1.—The three craniofacial normal skeletal types.

These three types correspond respectively, from the general somatic point of view, with three fundamental types distinguished by the Italian Constitutionalistic School as longitype, normotype, and brachytype, and also approximately to the ectomorph, mesomorph, and endomorph types of Sheldon (1940). These three skeletal types of head are prototypes, and it is rare to find individuals in which all the characters which distinguish them are present. In reality it happens that in most cases the characters of one type are mixed and combined with the characters of the other two types, thus giving origin to heads which appear different from one another and which cannot be superimposed.

To recognize these skeletal types is not, therefore, in itself sufficient for the diagnosis, but it represents the indispensable element not to be lost in the sea of variations, which only if considered within the types have an ordered and significant statistical behaviour.

With the presupposition that the absolute value of each character has no importance, but only the total resultant of all the characters, and that antagonistic variations (that is: in the prognathic and retrognathic sense) neutralize each other, we made a study to ascertain the limits where there was compensation between opposite variations, to find out a practical diagnostic method of dento-facial anomalies.

With the exclusion of the special case of bimaxillary protrusion, it must be considered that the variations are equally balanced every time occlusion is normal.

It is well known that the positions of the jaws and of the teeth are the resultant of complex skeletal phenomena, which are concerned with the most remote structures of the skull. To reach a practical diagnostic method, we must consider only those dimensions and ratios which have a direct influence on the mutual position of the teeth. It is therefore necessary to fix, first of all, these factors and then to choose measures which are of significance.

The conventional planes used until now cannot be trusted because: (1) errors arise owing to the great variability of the points of reference; (2) they are studied for a single type of head.

Let us now see which factors influence directly the mutual position of the teeth in the

anteroposterior plane, and how to measure them. They are mainly as follows:—

1. Anteroposterior Ratio of the Maxillary and Mandibular Bony Bases.—Two elements determine this ratio, dimensions of the bases and their relation. In fact, the upper jaw is situated with its posterior border forward at a variable distance from the most posterior point of the mandible. Therefore, to calculate the anteroposterior ratio of the anterior extremities of the maxilla and mandible, it would be necessary to add to the length of the upper jaw the distance which separates it from the condyle. In practice, as it would not be exact to add two distances which are not on the same straight line, it is necessary to take the distance in a straight line which separates the distal extremity of the mandibular condyle from the anterior extremity of the upper jaw.

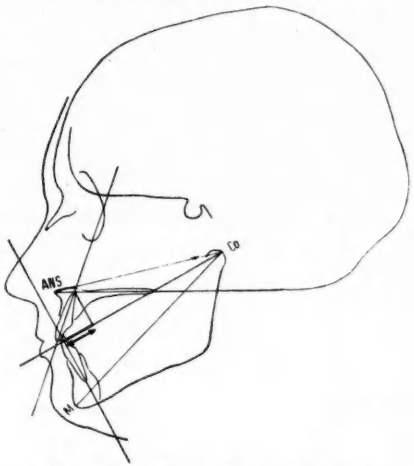

Fig. 2.—The difference between the distance Co–M and Co–ANS gives the anteroposterior ratio of the bony bases.

The angle ANS–Co–M gives the orientation of the mandible.

The difference between the angles that the lower and upper incisor axes make with the bisector of the angle ANS–Co–M gives the ratio of the axial inclination of the front teeth.

The anteroposterior ratio of the maxillary and mandibular bony bases is therefore found according to the difference between two distances: one between the extreme point of the condyle and the point of the chin farthest from it (Co–M = total mandibular length), the other between the same point of the condyle and the anterior nasal spine (Co–ANS) (*Fig.* 2).

2. Angle formed by the Two Lines which join the Condylar Point to the Chin Point and to the Nasal Spine (Angle ANS–Co–M).—This angle expresses the orientation of the mandible (*Fig.* 2). The progressive rotation downwards of the mandible causes a proportional backwards movement of the chin.

3. Difference between the Axial Inclination of the Upper and Lower Front Teeth.—The measurement of the inclination of the teeth requires a plane or a line of reference. The bisector of the angle ANS–Co–M has been chosen because: (*a*) it is a function of measurements already used; (*b*) in the greatest majority of normal cases it has a constant behaviour with reference to the teeth (in 85 per cent of the cases it grazes the upper incisal edge), revealing in this a functional meaning (*Fig.* 2). Since the axial inclination of the front teeth is in this way connected to the plane to which it is referred, and which is always an arbitrary plane, it is necessary to introduce a new

Table I.—Behaviour of the Main Four Ratios in the Different Skeletal Types of Head

	Prognathic Type (150–159°)	Mesognathic Type (160–165°)	Orthognathic Type (166–178°)	Arithmetical General Average	Statistical General Average
Difference CoM–CoANS	16·02 mm.	18·91 mm.	21·05 mm.	18·99 mm.	19
Angle ANS–Co–M	36·04°	34·50°	33·72°	34·59°	34
Difference inclination front teeth	42·22°	46·74°	51·66°	47·33°	46
Difference projection apices front teeth	13·07 mm.	15·07 mm.	17·05 mm.	15·27 mm.	15

measure, having proportional behaviour, capable of compensating for the variations in position of the reference plane. This measure is the following:—

4. Distance in mm. between the Apices of the Upper and Lower Front Teeth in Projection on the Bisector of the Angle ANS–Co–M (*Fig.* 2).

prognathic, mesognathic, and orthognathic respectively, according to the difference in the fronto-facial profile angle. Then by examining the behaviour of the variations of the four ratios in these three groups it has been found that they are in relationship with the different skeletal types, as is shown in *Table I.*

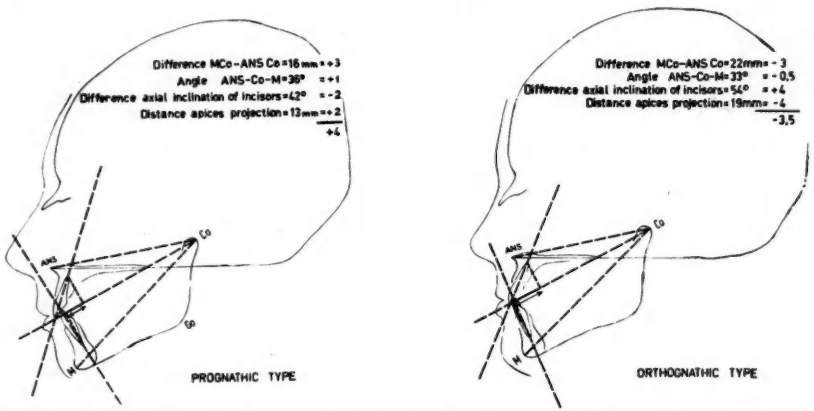
Difference MCo-ANS Co=16 mm = +3
Angle ANS-Co-M=36° = +1
Difference axial inclination of incisors=42° = -2
Distance apices projection=12 mm = +2
+4
PROGNATHIC TYPE
Difference MCo-ANS Co=22mm = -3
Angle ANS-Co-M=33° = -0,5
Difference axial inclination of incisors=54° = +4
Distance apices projection=19mm = -4
-3,5
ORTHOGNATHIC TYPE

Fig. 3.—In the prognathic type the score aims at positive values. In general the positive values of the ratio of the bony bases, of the angle ANS–Co–M, and of the relative position of the incisal apices aim to be compensated by the negative value of the ratio of axial inclination of the incisors.

In the orthognathic type the score aims at negative values. The negative values of the ratio of the bony bases, of the angle ANS–Co–M, and of the relative position of the incisal apices aim to be compensated by the positive values of the ratio of axial inclination of the incisors.

On the lateral skull radiographs of 120 untreated subjects between 11 and 12 years, with facial harmony and normal occlusion, the values of the above four ratios have been ascertained. The values obtained for each ratio have then been mathematically and statistically elaborated with the Standard Binomial Polygons Method by Frassetto (1936).

The subjects examined were classified, with the same statistical method, into three groups,

In the individual case, to find whether the combination of the values of these four ratios gives origin to a balanced whole or not, a positive or negative sign is given to the deviations from the average value of each ratio, according to their aim to increase (positive sign) or to decrease (negative sign) the overjet.

Further, not all the factors influence in a quantitatively equal way the overjet. In fact,

Table II.—Distribution of the Scores with Reference to the Different Types of Head

Values of the Score	Prognathic Type	Mesognathic Type	Orthognathic Type
Low values (from − 5 to − 1·5)	1	11	21
Average values (from − 1 to + 2)	7	31	17
High values (from + 2·5 to +6)	19	12	1

we have found that the deviation of 1 mm. in linear measurements is equivalent to 2° in angular measurements. The formula used is therefore as follows:—

	Average Value	*Displacement from Average Value*
Difference CoM-CoANS	19 mm. = 0	± 1 mm. = ± 1
Angle ANS-Co-M	34° = 0	± 1° = ± 0·5
Difference of inclination front teeth on bisector angle ANS–Co–M	46° = 0	± 1° = ± 0·5
Distance projection apices front teeth on bisector angle ANS–Co–M	15 mm. = 0	± 1 mm. = ± 1

Making the sum of the four values obtained in each normal individual, we obtain scores of between + 6 to — 5, with an average value of + 0·5. This large variability of the score in individuals who are all normal is explained by the fact that the normal overjet varies within sufficiently large limits. The distribution of these scores appears to be in reference with the various skeletal types as shown in *Table II*.

This important finding has permitted reduction of the range of variation of the normal score with reference to each type. So, in the normal subjects of the prognathic type, the score varies from + 6 to — 1·5, in those of mesognathic type from + 5 to — 2, and in those of orthognathic type from + 2 to — 5 (*Fig.* 3).

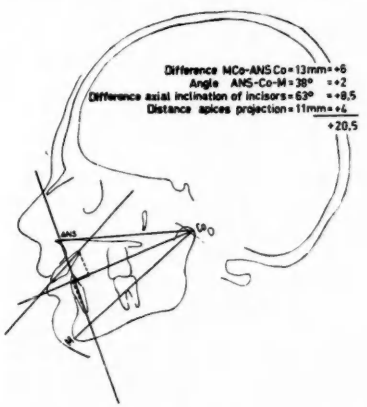
Difference MCo-ANS Co = 13mm = +6
Angle ANS-Co-M = 38° = +2
Difference axial inclination of incisors = 63° = +8,5
Distance apices projection = 11mm = +4
+20,5
Difference MCo-ANS Co = 27mm = -8
Angle ANS-Co-M = 33° = -0,5
Difference axial inclination of incisors = 63° = +8,5
Distance apices projection = 27mm = -12
-12

Fig. 4.—The cases of Class II, division 1, are characterized by remarkable positive scores. The cases of Class III are characterized by remarkable negative scores.

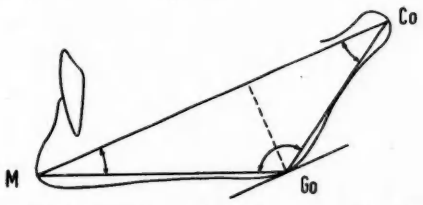

Fig. 5.—The distance Co–M gives the total length of the mandible.

The angle Co–M–Go indicates the relative development in the height of the rami. The angle M–Co–Go indicates the relative development in length of the mandibular body. The angle M–Go–Co indicates the degree of tilting of the body of the mandible on the rami.

For the two opposite anteroposterior anomalies, in cases of Class II, division 1, this formula gives remarkably positive values, always clearly superior to the maximum positive values found in normal subjects of the prognathic type; while in cases of Class III it gives negative values lower than the minimum found in normal subjects of the orthognathic type (*Fig.* 4).

This formula permits us also to ascertain whether the anomaly is due to the skeletal component or to the alveolar-dental component and in what degree.

To localize more exactly the anatomical region in which the anomaly has taken place, the analysis is completed with a series of supplementary measurements, namely:—

1. Assessment of the development of the mandible.

2. Assessment of the position of the mandible.

3. Assessment of the anteroposterior position of the upper jaw.

4. Assessment of the position of the front teeth with reference to their respective bases.

The assessment of the size and shape of the mandible is made by these measurements:—

1. *Total Length*: This is given by the distance existing between the condyle and the mental eminence (*Fig.* 5).

2. *Angle* Co–M–Go: Owing to the usual difficulty in fixing the exact position of gonion,

Table III.—Statistical Data of the Mandible Measurements

	Total Mandibular Length	Angle Co-M-Go	Angle M-Co-Go	Angle M-Go-Co
Range of normal variation	91–118 mm.	16–30°	25–39°	111–136°
Modal value	104 and 105 mm.	23°	33°	123° and 124°
Paranormal values	100–109 mm.	21–25°	31–35°	119–128°
Inferior distonormal values	91– 99 mm.	16–20°	25–30°	111–118°
Superior distonormal values	110–118 mm.	26–30°	36–39°	129–136°

Table IV.—Meaning of the Main Combinations of Variations in the Mandible Measurements

Total Length	Angle Co-M-Go	Angle M-Co-Go	Angle M-Go-Co	Characteristics of the Mandible
Average	Average	Average	Average	Normal size and shape
Average	Less	More	Average	Remarkable development of body with reduced development of rami
Average	More	Less	Average	Reduced development of body with remarkable development of rami
Average	Less	Less	More	Reduced development of body and rami compensated by a large gonial angle
Average	More	More	Less	Remarkable development of body and rami compensated by a reduced gonial angle
Less	Average	Average	Average	Proportional hypodevelopment of body and rami
Less	Less	More	Average	Hypodevelopment of rami
Less	More	Less	Average	Hypodevelopment of body
Less	Less	Less	More	Hypodevelopment of body and rami not sufficiently compensated by a large gonial angle
Less	More	More	Less	Reduced length due to an excessive reduction of the gonial angle
More	Average	Average	Average	Proportional hyperdevelopment of body and rami
More	Less	Less	More	Increased length due to an excessive opening of the gonial angle
More	Less	More	Average	Hyperdevelopment of body
More	More	Less	Average	Hyperdevelopment of rami
More	More	More	Less	Hyperdevelopment of body and rami not sufficiently compensated by a small gonial angle

we have chosen the most distant position from the line which expresses the maximum length of the mandible. This angle indicates the relative development in the height of the rami (*Fig.* 5).

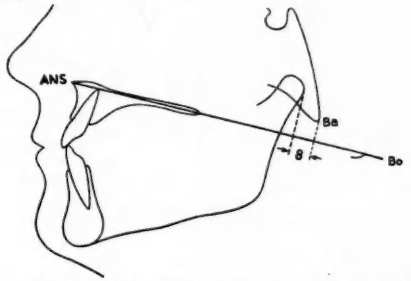

Fig. 6.—The distance between the basion and the projection of the most posterior point of the condyle on the line ANS–Bo gives the anteroposterior position of the condyles.

3. *Angle* M–Co–Go: This angle gives the relative development in length of the mandibular body (*Fig.* 5).

4. *Angle* M–Go–Co: This angle shows the degree of tilting of the body of the mandible on the rami (*Fig.* 5).

The statistical results of these measurements are summarized in *Table III.*

The values of the above four measurements are entirely relative, and to have an idea of the development and shape of the mandible they should be correlated with one another. For this purpose we have made a table in which are shown the main possible combinations (*Table IV*).

The position of the mandible is determined by making two measurements:—

1. *Angle* ANS–Co–M: which indicates the tilting of the mandible.

2. *The Distance between the Basion and the most Posterior Point of the Condyle in Projection on the Line* ANS–*Bolton Point.*—This distance indicates the anteroposterior position of the condyles with reference to the cranial base (*Fig.* 6).

The statistical data concerning these measurements are summarized in *Table V.*

In order to judge, though approximately, the more or less advanced position of the upper jaw, we refer to the rule of Muzj (1948), according to which, in ideal conditions, the anterior nasal spine should be found more or less on the extension of the line connecting the frontal point to the nasion.

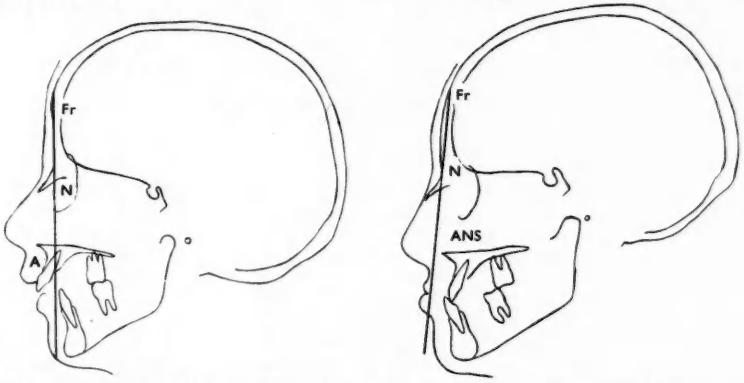

Fig. 7.—In cases of Class II, division 1, when the extension of the line Fr–N passes on the point A or behind it, the upper jaw is generally situated too much advanced.
In cases of Class III, when the extension of the line Fr–N passes in front of the ANS point, the upper jaw is generally in a posterior position.

In cases of Class II, division 1, when the extension of the Fr–N line falls behind point A, it is deduced that the upper jaw is too far advanced in position (upper total protrusion) (*Fig.* 7). Vice versa, in cases of Class III, when the above-mentioned line passes in front of the anterior nasal spine, it is deduced that the upper jaw is in a posterior position (upper retrusion) (*Fig.* 7).

The position of the front teeth are established by taking the following measurements, viz.:—

1. Distance of incision (in projection on the ANS–PNS line) from the anterior nasal spine and the angle that the upper incisor axis forms with the ANS–PNS line (*Fig.* 8).

2. The distance of inferior incision (in projections on the M–Go line) from the point M, and the angle that lower incisor axis forms with the M–Go line (*Fig.* 8).

The statistical data of these four measurements are summarized in *Table VI.*

Table V.—Statistical Data of the Measurements giving the Position of the Mandible

	Angle ANS-Co-M	*Distance Basion Projection–Condyle Projection on* Bo-ANS
Range of normal variations	26°–44°	2·5–16 mm.
Modal value	34°	8 mm.
Paranormal values	32°–37°	6–10·5 mm.
Inferior distonormal values	26°–31°	2·5–5·5 mm.
Superior distonormal values	38°–44°	11–16 mm.

For both upper and lower incisors an angular measurement has been used as well as the linear measurement.

These two measurements make it possible to determine whether the protrusion or retrusion of the incisors is due to their axial inclination or to variations in the anteroposterior position in relation to their respective bony bases.

To be brief we do not report the statistical data obtained by examining the values of the above 10 measurements in relationship to the different skeletal types of head. We only state that for the majority a clearly significant behaviour is shown.

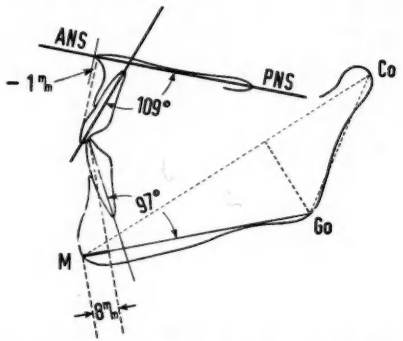

Fig. 8.—The distance between the point ANS and the projection of the incision on the maxillary basal plane gives the degree of protrusion of the upper incisor. The angle that the upper incisor axis forms with the maxillary basal plane gives the degree of axial inclination of the upper incisor. The distance between the point M and the projection of inferior incision on the mandibular plane (line M–Go) gives the anteroposterior position of the lower incisor. The angle that the lower incisor axis forms with the mandibular plane gives the degree of axial inclination of the lower incisor.

Table VI.—Statistical Data of the Measurements giving the Positions of both Upper and Lower Incisors in Relation to their Respective Bases

	Distance ANS– Incision	Angle Superior Incisor ANS-PNS Plane	Distance M point Inferior Incision	Angle Inferior Incisor M–Go Plane
Range of normal variation	− 10 to + 9 mm.	94–124°	0·5–16 mm.	80–112°
Modal value	− 1 mm.	109°	8 mm.	97°
Paranormal values	− 3 to + 1·5 mm.	105–113°	5·5–10·5 mm.	92–101°
Inferior distonormal values	− 10 to − 2·5 mm.	94–104°	0·5–5 mm.	80–91°
Superior distonormal values	+ 2 to + 9 mm.	114–124°	11–16 mm.	102–112°

The standard values reported are for the age between 11 and 12 years. They can, however, also be used with sufficient approximation in the nearer ages to the chosen one.

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ABSTRACTS FROM OTHER JOURNALS

Bone Implants in Periodontal Diseases—A Further Study

A comprehensive review of the literature concerning bone implants in the treatment of periodontal diseases is followed by a report of 35 implants inserted by the author, or members of the staff of his department. These implants were in 27 patients, of whom 11 were male and 16 female; the age distribution being 15–20 years 2, 21–30 years 10, 41–50 years 3, 51–60 years 2. Some form of splinting was used in 8 cases. The intrabony pocket varied from 6 to 16 mm. in depth, except for two cases where an attempt was made to raise the level of a more or less flat interdental crest of alveolus. Most of the teeth involved were in the anterior region, but premolars or molars were involved in 6 cases. Three of the implants were of autogenous origin, 20 homogenous, and 4 with an organic bovine bone.

After discussing the problem the author describes his technique in detail and analyses the results. He considers 11 were very satisfactory, 11 reasonably satisfactory, and 5 unsatisfactory. Where there was filling in of the bone defect or a substantial part of it, a pocket of 4 mm. or less, and freedom of the gingiva from inflammation or suppuration, the result was considered to be very satisfactory; a limited amount of filling-in, a pocket of 6 mm. or less, and freedom from suppuration and gingival inflammation were regarded as reasonably satisfactory; no bone regeneration, complete disappearance of the implant, and a pocket greater than 6 mm. was considered to be unsatisfactory.

Sixteen radiographs are presented of one case which was considered to have been unsatisfactory. Implanted fragments of lamellar bone are demonstrated lying in dense and mainly inactive fibrous tissue. In some places a little irregular woven bone had been formed, sometimes on the surface of a fragment of implanted bone, sometimes between the implanted fragments. The most striking feature of the specimen was the complete absence of osteoclastic activity, and very little evidence of past resorption. The field of the implant was free from the inflammatory cells, but there was a moderate degree of lymphocytic and plasma-cell infiltration near the pocket of the epithelium.—Cross, W. G. (1957), *J. Periodont.*, **28**, 184.

Angular Stomatitis

In answer to the question:—

A young woman developed fissures at the angles of her mouth during a recent pregnancy. These have persisted despite treatment with vitamin preparations and an ointment containing neomycin and hydrocortisone. Her teeth are healthy. What is the aetiology and treatment of the condition?

The following reply was given:—

Fissures at the angle of the mouth (angular stomatitis) are often evidence of nutritional deficiency, especially in pregnancy. They may be associated with an iron deficiency anæmia and achlorhydria or lack of one of the components of the vitamin-B complex, notably riboflavine. Sometimes the aetiology is obscure and there is no valid explanation for their presence. A full blood-count and test meal should be included in the investigation. Although in the case described vitamin preparations have not proved helpful it is possible that their potency has not been sufficient. It is suggested that tablets of aneurin. co. fort. of the National Formulary (two tablets thrice a day) might be helpful. These tablets consist of aneurine (5 mg.), riboflavine (2 mg.), nicotinamide (20 mg.), and pyridoxine (2 mg.).—*Brit. med. J.* (1957), **2**, 1007.

Nitrous Oxide Anæsthesia without Harm

A technique of nitrous oxide anæsthesia of short duration is described which depends on routine nitrogen "wash-out" by administration of pure oxygen for two to two and a half minutes prior to the administration of pure nitrous oxide.

The author has used this technique for two years. Dental surgeons have appreciated the

apparent lack of anoxia nausea and delirium, and patients have mentioned that the unpleasant sensations associated with increasing anoxia were removed.

At least 20 per cent oxygen as well as supplementary agents are necessary if the surgeon requires more than 2–3 minutes for the operation.—MOSTERT, J. W. (1958), *Brit. med. J.*, **1**, 502.

Cephalometric Study of the Clinical Rest Position of the Mandible II

Further studies were made of the cephalographs of a number of patients described in a previous study as having lost vertical dimension as a result of the loss of occlusal contacts. The material was considered in two groups: (1) Those in whom the dentures provided had incorporated adequate provision for free-way space; and (2) Those in whom the free-way space was reduced or obliterated. An estimate was made in each case of the contribution to the loss in vertical dimension made by bone loss. It was found that the presence or absence of free-way space was not closely related to the amount of bone loss. It is suggested that the rest posture of the mandible is one factor among many in deciding the reaction of the alveolar ridges to the insertion of dentures.—ATWOOD, D. A. (1957), *J. pros. Dent.*, **7**, 544.

A New Method of Demonstrating the Retention of Foodstuffs in the Mouth, with Special Reference to Different Forms of Sweet

The work done so far is insufficient to allow final conclusions to be reached.

Further work is continuing on more subjects and with the use of different types of confectionery and foodstuffs. Certain conclusions are, however, drawn from the work so far done.

The incorporation of blue copper, phthalolcynin dye in foodstuffs offers a method by which the disposition of food in relation to teeth can be tested. It is sufficiently stable and colourful to allow photographic reproduction of both macroscopical and microscopical results. It would appear from the results so far obtained that the chewing of toffee results in very considerable quantities being retained in and around the teeth for considerable periods, in many instances over one hour after chewing.

There appears to be a very considerable difference in both the quantity and time of retention between toffee on the one hand and chocolate and boiled sweets on the other.

The chewing of a toffee results in many instances in parts of it being forced into the fissures even when these are small. The presence of the toffee in small interstitial cavities and even in cervical ones is also noteworthy.—MACGREGOR, A. B. (1957), *Proc. R. Soc. Med.*, **51**, 41.

Antibiotics in Root-canal Therapy

A report is made on a search for a drug to replace Grossman's paste (which is objected to on allergic grounds and difficulty of manipulation) which could be used in teeth of young patients with wide apical foramina and gangrenous pulps. Three antibiotics fulfilled the author's conditions. These were polymyxin, neomycin, and bacitracin. When the effectiveness of each was determined the three antibiotics were combined in solution and tested *in vitro*. They were found to be synergistic in action. Fungicides were studied to combat the yeasts and added to the solution which was called P.N.B. The mixed solution was tested *in vivo* in 62 cases. One dressing was sufficient to clean 47 per cent of root-canals of bacteria; 21 per cent required five dressings. P.N.B. is used after thorough reaming of the canal (the importance of this step is stressed) and after alternate irrigation with chlorinated soda solution and hydrogen peroxide ending with the former. Finally, distilled water is used. Irrigation of the canals with P.N.B. using a Record syringe is followed by the insertion of a paper point saturated with P.N.B. solution. Antibiotics used in P.N.B. are toxic parentally but not when used locally in the root-canal. It is believed that they do not produce resistant strains or sensitize the patient.—CRAN, J. A. (1957), *Aust. dent. J.*, **2**, 183.